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PHOTO- AND CATHODOLUMINESCENCE MG-DOPED ALUMINA CERAMICS

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Abstract. On numerous occasions Mg is used as an alumina initial matrix impurity while creating anion-deficient structure.Magnesium application as an alumina ceramic dopant expands the boundaries of potential applications of this material, for instance to be used as a phosphor, a scintillator and a laser material.A special attention is given to the modeling of optical properties, and in particular to the study of defects in magnesium aluminate spinel.Recently a $MgAl_2O_4$ spinel with different impurities has been studied as an initial matrix for perspective use in optics.In that respect the purpose of the work is to study changes of Al_2O_3:Mg ceramic luminescent properties depending on synthesis conditions.

The samples under study in a disk form (diameter equal to 10 mm and thickness to 1.9 mm) were made by the cold pressing method on a mechanical press under the pressure of 0.42 GPa from α-Al_2O_3 powder. The compacts were initially annealed in air at the temperature of 450 °C for 2 hours. A doping was carried out by samples impregnating in a solution of Magnesium (II) nitrate hexahydrate (the ion concentration in range of 0.1–6.85 wt. %) at a room temperature for 1 hour. Compacts annealing was conducted during 2–4 hours at temperatures from 1400 °C to 1700 °C under vacuum and in air. Samples characterization was made by methods of X-ray diffraction (XRD) and X-ray fluorescence (XRF) analyzes. Pulse cathodoluminescence (PCL) spectra were obtained on the spectrometer “Klavi” on exposure of the sample to electron beam of 130 keV. Photoluminescence (PL) spectra were measured on a spectrometer LS-55 in the fluorescence mode.

PCL and PL spectra have been measured to evaluate the effect of a dopant concentration on a luminescence both intrinsic centers of alumina and impurity centers. It is shown that Mg doping leads to forming a new luminescence band in PCL spectra with the maximum at 518 nm. Concentration growth of Mg ions results in a luminescence increase on this band, what is illustrative of forming luminescence centers Mg^{2+} of magnesium aluminate spinel and it can also evidence F_2^{2+} aggregate centers of the alumina initial matrix. The similar effect is observed during PL spectra analysis. During ceramic annealing in air an increase in the magnesium ion concentration reduces the emission intensity of manganese and chromium impurity bands (673 and 693 nm) in the PL spectra. On the other hand, in ceramic doped in the solution with Mg concentration of 6.85 wt. % more intensive emission bands are observed in the spectra low wave region compared to a undoped ceramic and a ceramic with less Mg concentration. During annealing under vacuum at temperatures higher than 1500 °C a wide luminescence band with the maximum at 640 nm is observed for alumina ceramics with the highest possible concentration of Mg ions in the solution during impregnation (6.85 wt. %). It should be mentioned that the band described has the maximum intensity at the annealing temperature 1600 °C. Since this band is not detected for undoped ceramic, it is fair to assume that Mg ions in a spinel phase are responsible for the luminescence in this band.

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